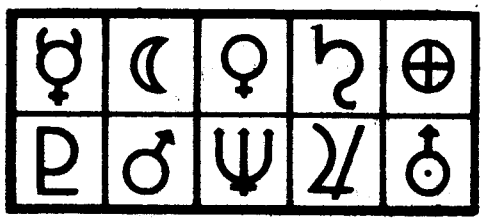

PLANETARY QUARANTINE

QR 7

DECEMBER 1967

SANDIA LABORATORIES QUARTERLY REPORT - PLANETARY QUARANTINE PROGRAM

PLANETARY QUARANTINE DEPARTMENT 2570

SANDIA LABORATORIES

OPERATED FOR THE U. S. ATOMIC ENERGY COMMISSION BY SANDIA CORPORATION | ALBUQUERQUE, NEW MEXICO; LIVERMORE, CALIFORNIA

Sandia Laboratories Quarterly Report - Planetary Quarantine Program

Seventh Quarterly Report of Progress

for

Period Ending December 31, 1967

Planetary Quarantine Department
Sandia Laboratory, Albuquerque, New Mexico

December 1967

Project Nos. 340.229.00
340.229.01

This work was conducted under NASA Contract Numbers R-09-019-040 and H-13245A.

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The following is a summary of the Planetary Quarantine Department activities being pursued, and the progress made, during the fourth quarter of calendar year 1967.

1. Objective Hierarchy

   A. Description. In order to determine what actions are needed to achieve planetary quarantine objectives on a cost optimal basis, an "objective hierarchy" is being constructed. A description of this approach can be found in previous quarterly reports or in a paper entitled, "A Systems Approach to Contamination Control", to appear shortly in the Proceedings of the NASA/AEC sponsored Symposium on Current and Advanced Concepts in Instrumentation and Automation in Contamination Control.

   B. Progress. As reported in the previous quarterly report, the modeling of the primary objectives of planetary quarantine is complete. Secondary and tertiary objectives are partially modeled. Activity has been started to structure the total objective hierarchy without recourse to quantitative modeling.

2. Microbial Death Models

   A. Description. A reliable model of microbial deactivation is needed for reasons described in quarterly report QR 5 and in "A Rational Model for Spacecraft Sterilization Requirements", Sandia Laboratories Research Report, SC-RR-67-256.

   B. Progress. A sterilization model based on the assumptions that microbial death in a lethal thermal environment is the consequence of chemical reactions was presented in the aforementioned research report. A fit to convex survival data for $106^{o}C$, $125^{o}C$, and $135^{o}C$

was given in this report. A fit to concave survival data for 125°C, 135°C, and 145°C was given in Sandia Laboratories Quarterly Report - Planetary Quarantine Program for Period Ending September 30, 1967, and in "A Rational Model for Thermal Sterilization of Microorganisms" to appear in Mathematical Biosciences. The fits referred to were obtained by fitting survival curves at the two lower temperatures by varying reaction rates and using the predicted reaction rates, via the Arrhenius equation, for the higher temperature.

The Arrhenius equation is at all times used to relate reaction rates to temperature, as it is naturally intended. Having gained some confidence in the model by using it, in this fashion, with both concave, and convex data, this quarter has been occupied with trying to prepare a practical means of using the model in actual sterilization situations.

The process of fitting the data, as described above, involved time at the computer console and a knowledge of parameter sensitivities by the operator. A computer package which automatically does the curve fitting is being developed. Computer inputs are data points for three lethal temperature levels. Outputs are reaction rates and a description of the death systems which will give the fit. Optional outputs include predicted survivors at various temperature levels and for variable temperature profiles.

3. Implementation System

A. Description.

(i) statistical estimates of space vehicle microbial burdens, in toto, by part, component, subassembly, in interior, exterior and occluded categories, as a function of time,

(ii) statistical estimates (projections) of total space vehicle bioburden at any time, based on the estimate at that time, and

(iii) theoretical tolerable limits as a function of time for all categories listed above.

B. Progress. The result of this activity may be viewed as an information system. It is necessary to specify the inputs, the nature of the processor, and the outputs. In these terms, the processor represents a computer code based upon the modeling referred to above and in previous quarterly reports.

A fundamental use of the system will be to provide information to the Planetary Quarantine Officer on which he can base confident certifications that spacecraft have met planetary quarantine policy requirements. This "sterilization certification" or "sterilization assurance" use implies certain types of information inputs and outputs. There can be several sources of inputs since several NASA activities will be generating bioassays and other significant data.

A report is nearing completion which analyses input sources and considers interface factors influencing the availability and usability of information from those sources. The report also addresses the organizational characteristics and operational methods which would be appropriate for drawing and using data from various sources.

It is hoped that the report will be useful in developing an approach to implementing the planetary quarantine responsibilities and in choosing a basic organizational structure for the implementa-

tion job. The implementation approach and its associated organizational structure will heavily influence the design of the information system. The nature of this influence is discussed in the report nearing completion.

4. Retrieval of Terrestrial Microorganisms from the Lunar Surface

A. Description. This activity has as its goal the determination of the probability that a lunar lander experiment retrieves at least one viable terrestrial microorganism that has been deposited on the moon by previously impacting spacecraft. This goal is to be attained by estimating the contribution of each spacecraft impacting the moon to the distributed microbial burden on the lunar surface.

B. Progress. A final report is in preparation and should be available early in 1968. All of the sub -problems described in previous quarterly reports have been satisfactorily resolved.

In addition, a computer code based on this model has been developed.

The model, in addition to attacking the problem stated above (Description), may be used to make probabalistic statements about the confinement of organic material to terrain near impact sites.

5. An Analysis of Laminar Flow Clean Rooms

A. Description. In order to more fully understand the problems associated with the control of air-borne particulate contamination in laminar flow clean rooms, a systems study has been undertaken.

B. Progress. The first phase of this study attempts to identify the factors that are "critical" to understanding the control of air-borne particulate contamination, and to determine, in some cases, some of the things that must be done to understand the effects of these factors.

This phase is about three-quarters complete, and a report is being prepared.

6. Contamination Control Principles

A. Description. The objective for this activity was to develop a document utilizing the systems approach to contamination control. Further, it should be suitable for management use in describing the need for and problems arising in contamination control. This project was carried out under NASA Contract No. W-12324.

B. Progress. Galley proofs were reviewed and mandatory changes were submitted to NASA. The document was published by the NASA Office of Technology Utilization as "Contamination Control Principles," NASA SP-5045, about December 1, 1967. This project has been completed.

7. Contamination Control Study

A. Description. The purpose of this project is to prepare a Contamination Control Handbook which can be used as an authentic source of technical information for such people as design, contamination control, manufacturing, and quality control engineers.

B. Progress. A significant level of accomplishment was maintained during the quarter as evidenced by the following activities:

1. Approximately 250 pages of handbook material were prepared in rough draft form. This brings the total to about 400 pages. Material completed this quarter includes technical information, tables, charts and sketches on the following subjects:

Cleaning of Surfaces

Ultrasonic Cleaning

Cleaning Agents

Balanced Laminar Air Flow Booths

Clean Rooms - Temperature and Humidity, Construction Features, Furniture and Equipment, Personnel, and Garments

Characteristics of Microbial Contamination

Control of Microbial Contamination

2. In addition to the items listed above, research, acquisition and preparation of material was initiated or continued on the following subjects:

   Verification of Surface Cleanliness

   Contamination Control in Hydraulic Systems

   Contamination Control in Liquids and Gases

   Monitoring Microbial Contamination

   Tables of Content, Glossaries and Bibliographies for various handbook sections

3. Mr. H. D. Sivinski participated in the NASA Oral Project Review at Marshall Space Flight Center (MSFC), Huntsville, Alabama, on November 16, 1967. Other attendees indicated a strong interest in the material presented and the handbook publication date.

4. Messrs. D. M. Garst and M. E. Morris visited Hydro-Tech, a contract cleaning company in Las Cruces, New Mexico, and the Aerojet General Corp. at the NASA Propulsion Engineering Office of White Sands Missile Range. The purpose of this trip was to obtain information on the cleaning and monitoring of hydraulic systems and system components.

5. Visitors to Division 2572 were Messrs. Conrad Jacobson and Robert Wimmers from the DuPont Company. Discussions were held concerning ultrasonic cleaning,cleaning agents, and cleanliness monitoring.

8. Vacuum Probe Development. Most of the effort normally expended for Planetary Quarantine Systems Support activities was diverted to the contamination control handbook project, NASA Contract No. H-13245A. However, some effort was devoted to redesign of the vacuum probe filter holder.

A. Description. The vacuum probe has been developed in an effort to evaluate lightly loaded large surface areas for bacterial contamination. This device is described in reports SC-RR-67-114 and SC-RR-67-688.

B. Progress. A redesign of the filter holder section of the vacuum probe is underway. This was necessary due to discontinuation of the commercial filter holder that was used on earlier models. A metal casting technique, developed at Sandia, is being investigated as a possible means of fabrication.

Three models of the vacuum probe described in QR 6, September 1967 were completed and appeared to operate satisfactorily. However, these units are fairly expensive to manufacture compared to units fabricated by the metal casting technique.

Drawings of the new model are to be completed in early January 1968, and pilot models are expected to be completed by the end of January 1968.

APPENDIX

Publications:

1. C. A. Trauth, Jr., "A Multi-Stage Decision Model for Mission Non-contamination Requirements", accepted December 28, 1967, accepted for publication in Space Life Sciences.
2. H. D. Sivinski, W. J. Whitfield, J. A. Paulhamus, "Contamination Control Principles", NASA SP-5045, Technology Utilization Division, Office of Technology Utilization, National Aeronautics and Space Administration, Washington, D. C.

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